Chapter 3
Artificial Intelligence and Its Integration with Regenerative Medicine Approach

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ABSTRACT

Artificial intelligence (AI) and regenerative medicine are becoming inextricably linked. As a result, the long-term outlook for the advancement of AI, regenerative medicine, and stem cells in the healthcare industry is incredibly bright. AI is being used in healthcare to discover new drugs and to provide personalized medicine based on big data. It can improve medical diagnosis and treatment plans. Regenerative medicine has the potential to repair damaged tissues and organs through stem cell-based regenerative medicine. Stem cell research is also undergoing significant development as a major component of the approach to regenerative medicine. In the future, it is expected that it will contribute to more personalized and more effective treatments. Integrating AI can help model and simulate cellular behavior, analyze, and process images for cell tracking and tissue engineering, and analyze large amounts of genomic and proteomic data. Together, these fields have the potential to transform healthcare and improve patient outcomes.

DOI: 10.4018/978-1-6684-8337-4.ch003

INTRODUCTION

Recent advancements in biomedical research along with the basic understanding of human health and disease mechanisms have led to a rapid evolution of modern medical technologies. Regenerative medicine has been at the forefront of providing revolutionary research technologies and approaches that have been instrumental in redefining and reinvigorating medical practice (Altyar et al., 2023). As defined by the Association for the Advancement of Blood & Biotherapies, regenerative medicine involves "replacing or regenerating human cells, tissues, or organs to restore or establish normal function" (Mason & Dunnill, 2008).

Breakthroughs in stem cell biology and clinical evaluation of regenerative therapeutics are prime examples of the growing synergisms between basic, translational, and clinical research technologies. Stem cell-based technologies are being used to treat several disorders, including autoimmune, orthopedic, cardiovascular, radiation-induced damage, asthma, and liver disease. However, there remain barriers and constraints that need to be tackled before the full potential of regenerative medicine can be unleashed, especially from a technical, social, regulatory, and ethical standpoint (Gardner et al., 2015).

To overcome these obstacles, the integration of artificial intelligence (AI), a growing field at the cross-section of computer sciences and engineering technology, is critical and advantageous. By employing an AI-driven manufacturing strategy, personalized regenerative medicine may soon become commercially viable on a larger scale. AI can assist in determining stem cell viability, functionality, efficacy, and safety before it is administered to the patients. Furthermore, AI could address the complex scenarios in regenerative medicine that could be prone to errors (Mukherjee et al., 2021; Srinivasan et al., 2021).

Over the past five decades, there has been a significant uptick in research and development involving AI incorporation in the healthcare field (Ruffle et al., 2019). AI has been employed to improve clinical operations, workflow efficiency, disease diagnoses, treatment monitoring, and the precision of medical interventions, thereby enhancing patient outcomes, hospital experience, and care satisfaction(Kumar et al., 2023).

Given the benefit of the integration of AI with regenerative medicine, we believe that their collaboration could significantly transform the future of healthcare practice. At the same time, AI could be utilized in ways that would supplement (rather than replace) human intelligence by making the AI framework more natural and easier to adopt. Herein, we will discuss the recent advances in AI and regenerative medicine, their integration and application, and the issues regarding their use in medical practice.

BASICS OF ARTIFICIAL INTELLIGENCE

AI is not a single technology, but rather a combination of several interlinked modalities (Figure 1). Although most technologies could be related directly to the healthcare industry, the processes and tasks they support vary considerably (Howard, 2019). Machine learning (ML) currently dominates AI research in medicine. This is mostly because ML can be applied to a wide range of complex tasks, such as assisting physicians with disease diagnosis and personalizing treatment for each patient. A key characteristic of ML is its capacity to "learn and apply" acquired knowledge to similar situations by using various algorithmic methods (Chen & Decary, 2020; Howard, 2019).